

R&S®DF-ATC-S

ATC DF System Solution

Accurate and reliable
direction finding for civil and
military air traffic control



R&S®DF-ATC-S ATC DF System Solution At a glance

The new ATC direction finding solution is a direction finding (DF) system especially designed for ATC controllers to obtain accurate DF results for up to 32 channels in parallel.

The new R&S®DF-ATC-S air traffic control DF system solution provides accurate and reliable direction finding for both civil and military airports. The R&S®DF-ATC-S system enables ATC controllers to accurately determine the direction to the aircraft on the basis of its radio transmissions. The DF results are used to convey to the pilot the magnetic heading toward the airport (QDM) and can be shown on additional radar or map displays. This helps to reduce call-sign confusion and to identify responses from wrong aircraft. The increased safety makes it possible to handle more flights per hour by reducing the time gaps between consecutive flights.

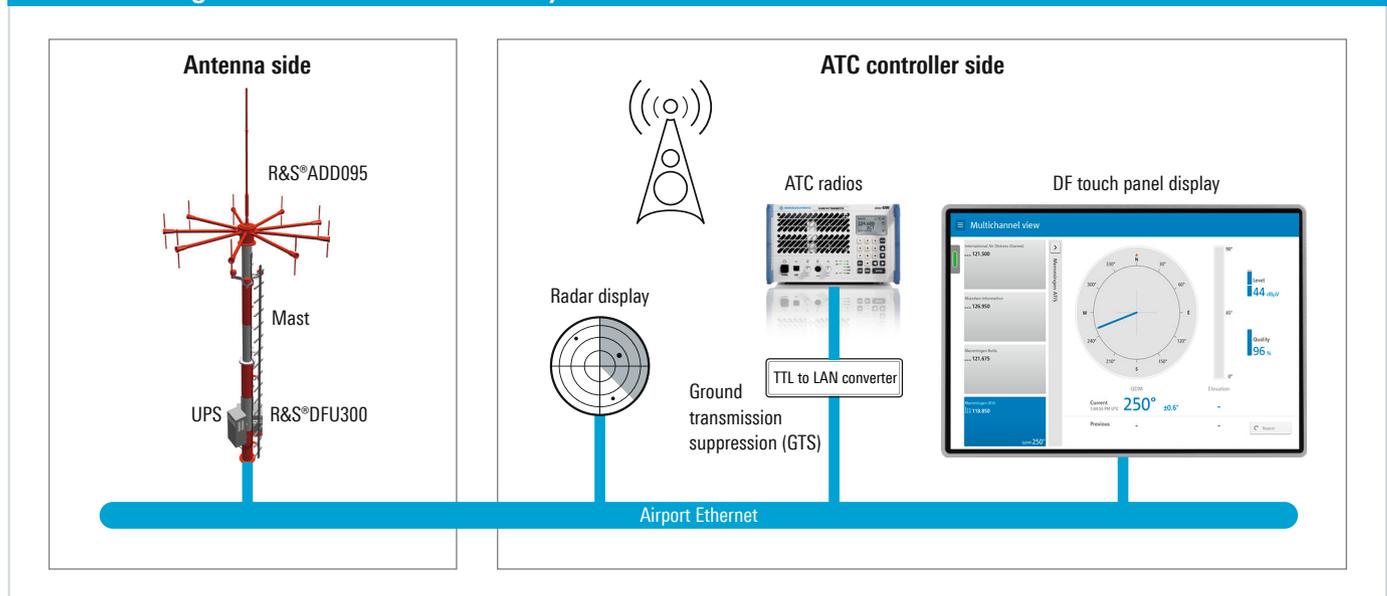
Possible configurations range from small airport DF systems with up to two frequency channels in the VHF aviation band to powerful systems with up to 32 frequency channels in parallel for seamless coverage of the frequency range from 118 MHz to 450 MHz. Future-proof 8.33 kHz channel spacing in the VHF aviation band is included.

The R&S®DF-ATC-S standard configurations are complete systems for integrators and ATC authorities and include all required components. The new solution will replace the current ATC DF system based on the R&S®DDF04E digital direction finder for air traffic control.

Key facts

- ▀ Helps to instantaneously identify which aircraft is transmitting to reduce misunderstandings and call-sign confusion
- ▀ Increases safety and situational awareness, which allows more flights per hour
- ▀ Seamless coverage of a wide frequency range from 117.975 MHz to 450 MHz with only one DF antenna
- ▀ Up to 32 frequency channels in parallel, with up to 28 channels inside and up to four channels outside the VHF airband, configurable at control GUI
- ▀ 8.33 kHz and 25 kHz channel spacing
- ▀ Result outputs on radar displays and in traffic management systems via a TCP/IP interface or RS-232 (optional)
- ▀ Optimized control software for ATC operators

Functional diagram of the R&S®DF-ATC-S system



R&S®DF-ATC-S ATC DF System Solution

Benefits and key features

Standard system configurations

- ▮ Four standard configurations to match the requirements of different airports
- ▮ Each standard configuration provides an all-in-one solution and is optimized for simple deployment and reliable operation
- ▮ Detailed documentation, installation, operating and maintenance manuals
- ▮ One partner for the complete ATC DF system including masts, installation support, training and maintenance

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One solution for all frequency channels with high DF accuracy and sensitivity

- ▮ Parallel direction finding on up to 28 VHF airband frequency channels from 117.975 MHz to 137 MHz, plus four out-of-band VHF airband frequency channels up to 450 MHz for simultaneously monitoring all important distress frequencies
- ▮ DF accuracy and measurement speed are equally high for all frequency channels
- ▮ R&S®ADD095 VHF DF antenna features a high level of DF accuracy, sensitivity and outstanding immunity to reflections
- ▮ Compact R&S®ADD317 VHF/UHF DF antenna optimized for semi-mobile scenarios
- ▮ Excellent large-signal immunity due to sophisticated preselection and extremely linear receivers

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Ergonomic operation and easy configuration

- ▮ Optimized graphical user interface specially designed to meet the requirements of ATC controllers
- ▮ Switching between different frequency channels with a fingertip
- ▮ Easy configuration of the number of channels and frequencies being monitored
- ▮ Different user rights for system users and administrators to restrict system configuration changes
- ▮ Support of day and night view

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Designed for easy maintenance

- ▮ Monitoring of system status and built-in self-test routines
- ▮ SNMP interface for integration into monitoring system
- ▮ Logging of system messages and DF results

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Standard system configurations

Standard system configurations as all-in-one solutions are defined to match the requirements of different customers and airports. Each solution comes with all required system components, complete set of documentation and few options e.g. antenna mast, obstruction lights or UPS. System setup and internal tests are executed before delivery to the customer for simple deployment, low maintenance effort and reliable operation. Installation support, training and maintenance can be provided.

Central component of each configuration is the compact and weatherproof outdoor R&S®DFU300 direction finder unit including DF system server, temperature control, power supply, GPS and Ethernet switch. Together with the DF antenna it is installed at the antenna site. Outdoor UPS, antenna mast and obstruction lights can be added as required.

Each configuration includes at least one high-contrast touch panel PC with the control software for administration and operation, plus one TTL-to-LAN converter for ground transmission suppression (GTS) for installation in the ATC tower or control room. GTS is used to support the air traffic controller by suppressing all bearings of their own radio transmissions.

Standard LAN network products shall be used to connect the R&S®DFU300 with the control and administration panels. If required, adapters for LAN to fiber or DSL converters can be added to handle long distances between the DF antenna site and the ATC tower.

Connection to customer-specific traffic management systems and/or radar displays also runs via LAN (TCP/IP). Alternatively, RS-232 interfaces are available for connecting radar displays.

The table below provides a comparison of the standard configurations and its capabilities followed by a short summary of each system configuration.

| Features and options | R&S®DF-ATC-S1 standard ATC DF system | R&S®DF-ATC-S2 standard plus ATC DF system | R&S®DF-ATC-S3 high-end ATC DF system | R&S®DF-ATC-S4 high-availability ATC DF system |
|---|--|---|--|---|
| VHF aviation channels, 117.975 MHz to 137 MHz | 2 | up to 4 | up to 28 | up to 28 |
| Frequency range | 117.975 MHz to 137 MHz | 117.975 MHz to 450 MHz | 117.975 MHz to 450 MHz | 117.975 MHz to 450 MHz |
| Channel spacing | 8.33 kHz/25 kHz | 8.33 kHz/25 kHz | 8.33 kHz/25 kHz | 8.33 kHz/25 kHz |
| Out-of-band channels, 137 MHz to 450 MHz | not supported | on request | up to 4 | up to 4 |
| System DF sensitivity ¹⁾ | 3 µV/m | 5 µV/m | 2 µV/m | 2 µV/m |
| System DF accuracy ²⁾ | typ. 1° RMS | typ. 1° RMS | typ. 0.5° RMS | typ. 0.5° RMS |
| Immunity to reflections | medium | medium | high | high |
| R&S®DFU300 direction finder unit | 1 | 1 | 1 | 2 (spare DF unit with dual network support) |
| Direction finding antenna | R&S®ADD317 (traffic red) | R&S®ADD317 (traffic red) | R&S®ADD095 (traffic red) | R&S®ADD095 (traffic red) |
| Integration kit | ✓ | ✓ | ✓ | ✓ |
| DF control touch panel | 1 | 1 | 1 (optionally more) | 1 (optionally more) |
| Administrator touch panel PC | optional | optional | 1 | 1 |
| Data interface for DF measurement result | not supported | not supported | ✓ | ✓ |
| TTL converter for GTS | 1 | 1 | 2 | 4 |
| Antenna mast, height: 5 m, with obstruction lights, red/white painting and ladder | optional ³⁾ | optional ³⁾ | optional | optional |
| Outdoor UPS (120 V or 230 V) | optional | optional | optional | optional |

¹⁾ Maximum number of supported VHF airband channels provisioned and 1 s integration time.

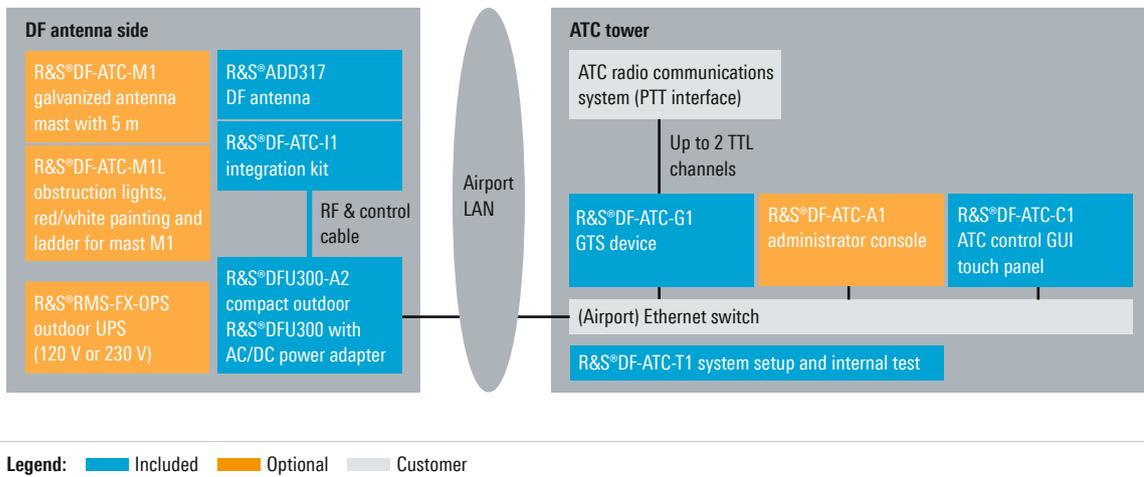
²⁾ Measurement in reflection-free environment. The RMS error is calculated from the bearings of evenly distributed samples versus azimuth and frequency.

³⁾ R&S®DF-ATC-M1 contains the galvanized antenna mast, R&S®DF-ATC-M1L adds obstruction lights, red/white painting and ladder.

R&S®DF-ATC-S1 system configuration

This configuration is intended for small airports requiring only one or two frequency channels within the VHF airband frequency range from 117.975 MHz to 137 MHz. This compact system configuration includes the narrow-aperture R&S®ADD317 VHF/UHF DF antenna. A galvanized antenna mast with 5 m height can be ordered optionally. Obstruction lights, red/white painting and ladder are available as well.

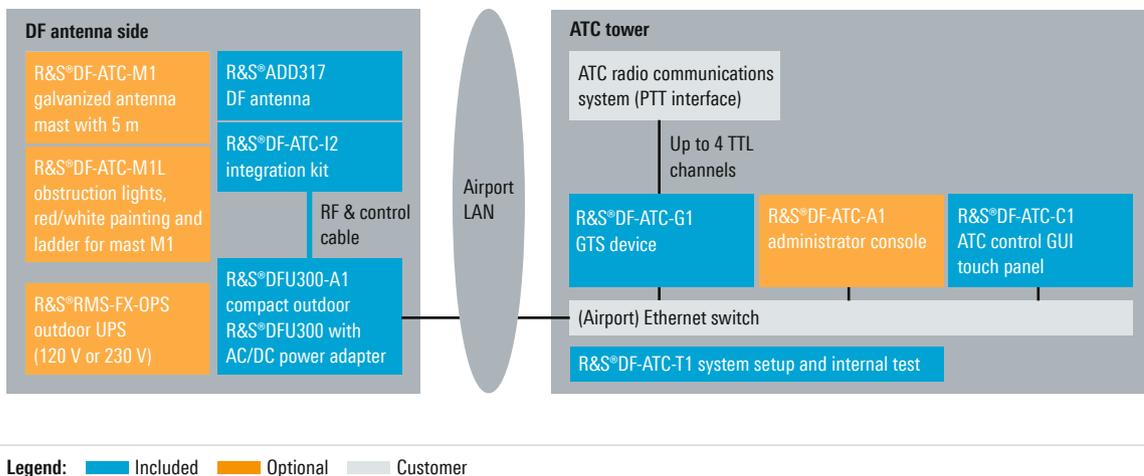
Basic system architecture for R&S®DF-ATC-S1 with main system components



R&S®DF-ATC-S2 system configuration

This configuration is almost identical with R&S®DF-ATC-S1 and supports up to four VHF airband frequency channels. Even additional out-of-band channels are possible on request but will impact DF sensitivity. It is designed for more flexibility and semi-mobile deployments.

Basic system architecture for R&S®DF-ATC-S2 with main system components

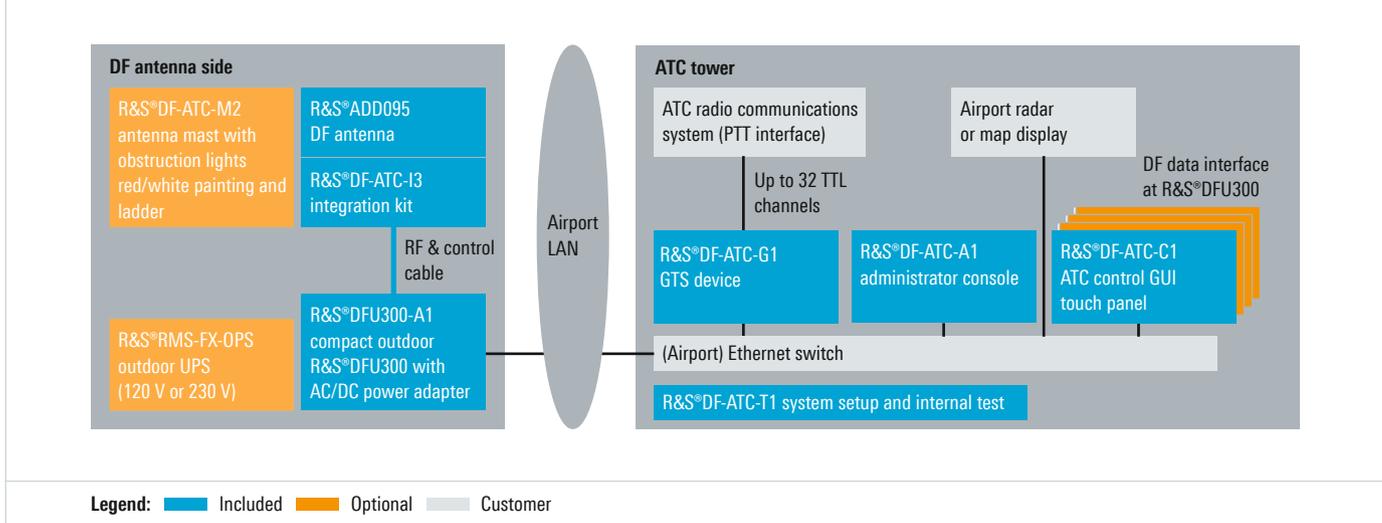


R&S®DF-ATC-S3 system configuration

This configuration provides the full functionality and includes the wide-aperture R&S®ADD095 VHF DF antenna for maximum DF accuracy and sensitivity. Up to 28 VHF airband frequency channels in parallel are supported, and up to four outside the VHF airband channels are configurable.

The TCP data interface outputs all DF measurement results such as DF azimuth values for external systems, e.g. radar or map displays. This configuration seamlessly covers the frequency range from 117.975 MHz to 450 MHz.

Basic system architecture for R&S®DF-ATC-S3 offering full functionality

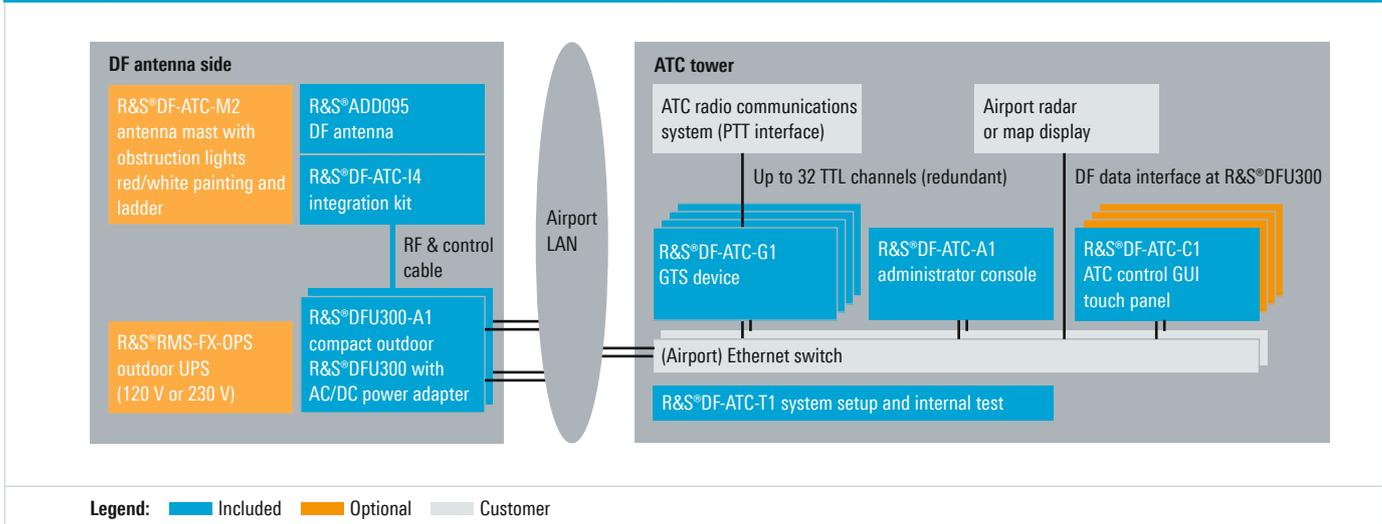


R&S®DF-ATC-S4 system configuration

This configuration is based on the R&S®DF-ATC-S3 configuration and provides the same functionality, in addition it comes with redundant system components for high availability.

The critical system components are redundant for increased availability. A second standby R&S®DFU300 direction finding unit can be activated in case of a system failure or unit failure; additional GTS devices are installed and all devices are connected over a redundant LAN configuration.

Basic system architecture for R&S®DF-ATC-S4 with system redundancy



One solution for all frequency channels with high DF accuracy and sensitivity

The core component of the new ATC DF system is the compact and weatherproof R&S®DFU300 direction finding unit with a wideband digital direction finder, which is fast enough to process a multitude of frequency channels simultaneously. Up to 32 frequency channels can be processed with the direction finder at speeds that provide high DF quality of each individual channel.

The wide frequency range of the direction finder, from 117.975 MHz to 450 MHz, is unique. This means bearings can be taken on all distress frequencies in the VHF/UHF range at the same time, independent of the ATC frequency range.

With the introduction of digital aeronautical radio in the VHF aviation frequency range, DF systems used for air traffic control have to support 8.33 kHz and 25 kHz channel spacing. The channel spacing can be changed in the R&S®ATC-DF-S system for all VHF frequencies individually via the graphical user interface.

The entire frequency range is covered by single DF antenna: the wide-aperture R&S®ADD095 with nine antenna elements for stationary or the narrow-aperture R&S®ADD317 for semi-mobile and cost-effective systems.

The direction finder uses the correlative interferometer DF method. This DF method is based on measuring the phase differences between the antenna elements of a circular array DF antenna, permitting the use of wide-aperture antennas that are highly immune to reflections and feature a high level of DF accuracy and sensitivity.

The R&S®DFU300 is designed for compliance with the regulations of the German "Federal Supervisory Authority for Air Navigation Services". Due to the parallel wideband signal processing, this high level of DF quality is available on all channels.



Connection panel of the compact and weatherproof R&S®DFU300 direction finding unit.

Ergonomic operation and easy configuration

The R&S®DF-ATC-S system configurations feature a graphical user interface specially designed for ATC controllers. The GUI design is optimized for small touch panel PCs that can easily be integrated into ATC control towers and operated by the users. Additional touch panel PCs can be added as required. Laptops, PCs and tablets can be used optionally, providing high flexibility.

Only the relevant information for the ATC controller is displayed, allowing the user to quickly change between different frequency channels. ATC controllers can adapt the displayed details according to their own preferences, select the used frequency channel and switch between day and night view quickly.

Configuration of the R&S®DF-ATC-S system is restricted to administrators. After the password for the administrator role has been entered, additional configuration screens are available for configuring the number of frequency channels and all parameters for each frequency channel.



Touch panel PC
with multichannel
standard view for
ATC controllers.

Designed for easy maintenance

Self-test capabilities are particularly important for safety-relevant applications such as air traffic control. The direction finder continuously checks more than 170 test points in the background during operation and compares the results with the nominal values. If one of these test points is outside the nominal value range, an error message is automatically generated.

Overall system status and system messages are available at all controller GUIs and are forwarded via the SNMP interface to a central monitoring system to quickly inform the administrator about problems. The R&S®DF-ATC-S administrator console allows the administrator to execute additional self-tests and provides more details about the test results.

All system messages and DF results are logged in a ring buffer for further analysis and history information. If necessary, this data can be regularly downloaded and archived on external storage systems for security reasons.

Our R&S®DF-ATC-S solution is based on standard IT equipment and the powerful wideband digital direction finder. This allows us to adapt to future ATC direction finding requirements.

Health monitoring: provides the status of the system and multiple sensors, shows device information and lists all system messages with additional details.

The screenshot displays the 'Configuration' page of the R&S DF-ATC-S administrator console. The page is titled 'Configuration' and shows the 'Health' status. The 'DFD device information' section lists the following details:

- Name: ROHDE&SCHWARZ DDF200M
- Firmware ID: 4073.1302.00
- Serial number: 100.831/002
- Firmware version: V02.10
- Firmware options: DF, WDF, SE, A1

The 'Sensors' section shows 9 sensors, all of which are 'Ok':

- Connection
- Voltage
- Temperature
- Frequency
- Overload
- Reference unlocked
- Warm up
- Int. communication
- GTS

Below the sensors, there are buttons for 'Device' (Cold reset, Warm reset, Short built-in test, Long built-in test) and 'Log files' (Commands, DDF data, Health). The bottom section shows a list of system messages with filters for Source (All, System, Device) and Type (All, Errors, Warnings, Info). The messages are:

- 9/28/2017 3:14:18 PM UTC [System] DF-ATC-A1-XXXXX modified settings: Channel "fnkl" has been deleted - Frequency: 423500000 Bandwidth: 25000 Threshold: 0
- 9/28/2017 3:14:16 PM UTC [System] DF-ATC-A1-XXXXX modified settings: Channel "Testchannel 350" has been deleted - Frequency: 357141667 Bandwidth: 0 Threshold: 2
- 9/28/2017 3:14:15 PM UTC [System] DF-ATC-A1-XXXXX modified settings: Channel "Testchannel 30" has been deleted - Frequency: 138475000 Bandwidth: 25000 Threshold: 2
- 9/28/2017 3:14:14 PM UTC [System] DF-ATC-A1-XXXXX modified settings: Channel "Testchannel 38" has been deleted - Frequency: 137108300 Bandwidth: 8333 Threshold: 3

System components

R&S®DFU300 compact and weatherproof ATC direction finder

The main component of the R&S®DFU300 is an accurate digital direction finder based on the correlative interferometer DF method. Along with its integrated control PC, power supply and Ethernet switch, the direction finder is accommodated in a compact weatherproof housing. The integrated temperature control system features active heating and cooling so that the R&S®DFU300 can be used across a wide temperature range.

Thanks to its GPS module, the R&S®DFU300 knows its exact geographic position and has an accurate time source.

For communications with control panel PCs and airport radar systems, an Ethernet interface is provided to connect to the airport LAN.

R&S®ADD317 VHF/UHF DF antenna

- Stationary narrow-aperture DF antenna covering the frequency range from 117.975 MHz to 450 MHz
- Multi-element DF antenna with five elements
- Integrated lightning protection with lightning rod; no impact on DF accuracy
- Optional antenna mast specifically designed for R&S®ADD317 at airports
 - Mast height: 5 m
 - Obstruction lights, red/white painting and ladder can be added

R&S®ADD095 VHF DF antenna

- Seamless coverage of a wide frequency range from 117.975 MHz to 450 MHz with only one DF antenna
- Wide-aperture DF antenna with nine antenna elements for high DF accuracy, sensitivity and immunity to reflections
- Integrated lightning protection with lightning rod; no impact on DF accuracy
- Optional antenna mast specifically designed for R&S®ADD095 at airports
 - Mast height: 5 m
 - Obstruction lights, red/white painting and ladder



R&S®DFU300 ATC direction finder.



R&S®ADD095 VHF DF antenna.



TTL-to-LAN converter box for ground transmission suppression (GTS).

TTL converter for ground transmission suppression

The TTL converter box has 16 input channels to be connected with the airport radiocommunications system. The DF ATC control software allows operators to configure for each input the corresponding frequency to be blanked as soon as it is used for their own transmissions. The control box is connected over Ethernet to the DF ATC control software.



Touch panel PC with control software.

Touch panel PC with control software

The ATC DF control software for ATC operators and administrators is installed on a touch panel PC to allow system control via the touchscreen. Mouse and keyboard are not required but can be used optionally. The touch panel PC runs under Windows 10 operating system and has a display size of 10.1" with 1280 × 800 resolution. It has adjustable brightness, a wide viewing angle and anti-glare surface for improved readability in brightly illuminated environments. At night or in a dark environment, the software's night view can be activated.

Data interface for DF measurement results

All DF results from the ATC system are provided in real-time to external systems over a TCP interface. The external system can be a radar system, map display or any other system in which DF results are of interest.

The following details are available for all configured frequency channels:

- Frequency
- Timestamp
- Azimuth and elevation value
- Overhead pass (OHP) flag
- Ground transmission suppress (GTS) flag

Specifications in brief

R&S®DFU300 ATC direction finder

| Interfaces | | |
|-----------------------------|-------------------------------|---|
| LAN | | 10/100/1000 Mbit Ethernet, RJ-45 (f) |
| GPS antenna | | SMA (f), 50 Ω |
| Antenna input | | N (f), 50 Ω |
| DF antenna control | | MIL connector (f) |
| Direction finding (DF) data | | |
| Frequency range | | 117.975 MHz to 450 MHz |
| DF method | | correlative interferometer |
| General data | | |
| Power supply | | +24 V ± 2 V DC, max. 300 W |
| AC/DC power adapter | nominal | 100 V to 240 V, 47 Hz to 63 Hz |
| | max. range | 90 V to 305 V AC, 47 Hz to 63 Hz |
| Operating temperature range | without direct sunlight | -40°C to +55°C |
| Storage temperature range | | -50°C to +70°C |
| Relative humidity | | 95% cyclic test, +25°C/+55°C |
| Protection class | | IP65 |
| Shock | | in line with EN 60068-2-27, MIL-STD-810-E, method 516.4, procedure 1 |
| Vibration | sinusoidal | in line with EN 60068-2-6 |
| | noise | in line with EN 60068-2-64 |
| EMC | | in line with EN 55032, ETSI EN 301489-1, ETSI EN 301489-22, ETSI EN 300676-1 |
| Dimensions | W × H × D, without mast clamp | 365 mm × 765 mm × 275 mm (14,37 in × 30,12 in × 10,83 in) |
| Weight | | 31 kg (68.34 lb) |

R&S®ADD317 VHF/UHF DF antenna

| | | |
|------------------------|---|---|
| Antenna type | | 5-element circular array |
| Antenna element type | | active dipoles |
| DF method | | correlative interferometer |
| Polarization | | vertical |
| Power supply | | from R&S®DFU300 |
| Dimensions | Ø × H, without lightning rod | approx. 1.05 m × 0.52 m (3.43 ft × 1.71 ft) |
| | Ø × H, with lightning rod | approx. 1.05 m × 1.34 m (3.43 ft × 4.40 ft) |
| Weight | | approx. 11 kg (24.25 lb) |
| Permissible wind speed | without ice deposit, with lightning rod | 200 km/h 275 km/h (survival) |
| | with 30 mm radial ice deposit | 180 km/h |

R&S®ADD095 VHF DF antenna

| | | |
|------------------------|--|--|
| Antenna type | | 9-element circular array |
| Antenna element type | | active dipoles, switchable to passive mode |
| Size of antenna base | | wide-aperture DF antenna |
| DF method | | correlative interferometer |
| Polarization | | vertical |
| Power supply | | from R&S®DFU300 |
| Dimensions | Ø × H, without lightning rod | approx. 3.06 m × 0.66 m (10.05 ft × 2.15 ft) |
| | Ø × H, with lightning rod | approx. 3.06 m × 2.94 m (10.05 ft × 9.64 ft) |
| Weight | without ice deposit, with lightning rod | approx. 85 kg (187.40 lb) |
| | with 30 mm radial ice deposit, with lightning rod | approx. 420 kg (925.94 lb) |
| Permissible wind speed | without ice deposit | 200 km/h, 275 km/h (survival) |
| | with 30 mm radial ice deposit | 180 km/h |
| MTBF | in line with SN 29500, +55°C, stationary operation | > 50 000 h, in line with standard SN 29500; +55°C; GF |

Ordering information

The R&S®DF-ATC-S solution comes in four predefined configurations to match the requirements of different airports.

Each configuration includes all necessary components for successful deployment of the ATC DF system at the airport. Some hardware and service options are provided to enhance the system.

| R&S®DF-ATC-S configurations | | |
|---------------------------------|---------------|--------------|
| Designation | Type | Order No. |
| Standard DF ATC System | R&S®DF-ATC-S1 | 3063.4002.02 |
| Standard Plus DF ATC System | R&S®DF-ATC-S2 | 3063.4102.02 |
| High-End DF ATC System | R&S®DF-ATC-S3 | 3063.4202.02 |
| High-Availability DF ATC System | R&S®DF-ATC-S4 | 3063.4302.02 |

| Hardware options | | |
|--|----------------|--------------|
| Designation | Type | Order No. |
| DF Control Touch Panel PC | R&S®DF-ATC-C1 | 3063.5009.02 |
| Administrator Touch Panel PC | R&S®AF-ATC-A1 | 3063.5044.02 |
| Antenna Mast for R&S®DF-ATC-S1/S2 (galvanized) | R&S®DF-ATC-M1 | 3063.5050.00 |
| Obstruction Lights and Painting for R&S®DF-ATC-M1 | R&S®DF-ATC-M1L | 3063.5096.00 |
| Antenna Mast for R&S®DF-ATC-S3/S4 (incl. obstruction lights, painting and ladder) | R&S®DF-ATC-M2 | 3063.5067.00 |
| Outdoor UPS (230 V) | R&S®RMS-FX-OPS | 3063.5080.02 |
| Outdoor UPS (120 V) | R&S®RMS-FX-OPS | 3063.5080.03 |

| Customer support options | | |
|---|---------------|--------------|
| Designation | Type | Order No. |
| Customer FAT in Memmingen, Germany | R&S®DF-ATC-T2 | 3063.5215.02 |
| Installation Support for R&S®DF-ATC-S (excluding travel costs and accommodations) | R&S®DF-ATC-T3 | 3063.5221.02 |
| Setting to Work/SAT Support for R&S®DF-ATC-S (excluding travel costs and accommodations) | R&S®DF-ATC-T4 | 3063.5238.02 |
| Training for R&S®DF-ATC-S (excluding travel costs and accommodations) | R&S®DF-ATC-T5 | 3063.5244.02 |

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Service that adds value

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Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

- | Environmental compatibility and eco-footprint
- | Energy efficiency and low emissions
- | Longevity and optimized total cost of ownership

Certified Quality Management

ISO 9001

Certified Environmental Management

ISO 14001

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